

## **PROPOSED REVISIONS TO GMI DRAFT DOCUMENTS**

Listed below are proposed revisions to the identified documents. Comments concerning the proposed changes, and recommendations for other changes, from the companies currently performing the GMI Risk Reduction Studies, and from other interested parties, are welcome and encouraged. A decision as to whether to incorporate the proposed revisions will be made following the review of any comments received.

**May 8, 2003**

### **GMI Requirements Document**

Table 3-1. Required GMI Channel Set and Required Performance

### **GMI Design Enhancements Memorandum**

Paragraph 4.1 Improved Surface Spatial Resolution

**Table 3-1. Required GMI Channel Set and Required Performance**

Channel #	Center Freq. $f_c$ (GHz)	CFS <sup>[1]</sup> (Stab+/-) (MHz) (Maximum Deviation)	Pass-band Bandwidth B (MHz) (Maximum)	Pol.	Integration Time for NEAT Calculation (ms)	NEAT <sup>[2]</sup> (K) (Maximum)	Antenna 3 dB beam width <sup>[3]</sup> $\theta_{3dB}$ (degrees) (Maximum)
1	10.65	10	100	V	11.4	0.55	2.05
2	10.65	10	100	H	11.4	0.55	2.05
3	18.70	20	200	V	6.7	0.65	1.20
4	18.70	20	200	H	6.7	0.65	1.20
5	23.80	20	200	V	5.3	0.85	0.95
6	36.50	50	1000	V	5.0	0.40	0.90
7	36.50	50	1000	H	5.0	0.40	0.90
8	89.0	100	4000	V	2.2	0.50	0.40
9	89.0	100	4000	H	2.2	0.50	0.40

**A. Abbreviations:**

- Freq. = Frequency
- Pol. = Polarization
- V = Vertical
- H = Horizontal
- stab = stability
- CFS= Center Frequency Stability
- K=Kelvin
- GHz=GigaHertz
- MHz=MegaHertz
- dB=decibel
- NEAT = Noise Equivalent Delta Temperature = Radiometric Sensitivity
- B = Pass-band Bandwidth

**B. Informational Remarks Regarding Table 3-1:**

- [1] The channel center frequencies and bandwidths in Table 3-1 have been selected to lie within the bands protected by NTIA allocation (Earth Exploration Satellite Service).
- [2] Radiometric sensitivity is defined in Section 3.1.4. The Integration Times provided are for use in calculating NEAT. Note: These times correspond to the motion through one channel 3dB beamwidth given the maximum beamwidths of Table 3-1 and an antenna rotation rate of 40 rpm. These times are not meant to suggest actual sensor integration times; these times are to be used only for NEAT calculation for comparison to required NEAT of Table 3-1.

- [3] The antenna beam widths for channels 1 – 5 are derived using the formula  $\theta_{3dB} = 1.27 \lambda/D$  (radians) where  $\theta_{3dB}$  is the half-power antenna beam width,  $\lambda$  is the electrical wavelength, and D is the projected aperture diameter of 1 meter. The antenna beam widths for channels 6 – 9 were selected in order for GMI to provide surface scene spatial resolution and spatial sampling comparable to that obtained by the Tropical Rainfall Measuring Mission (TRMM) Microwave Imager (TMI). Further detail on channel beam width requirements is found in Section 3.1.5.2. For channels 6 – 9, the required beam widths may be obtained by under-illumination of the antenna aperture.

#### **3.1.4 Radiometric Sensitivity**

The radiometric sensitivity (a.k.a. NE $\Delta$ T) is the minimum detectable change of the microwave power (in brightness temperature units) incident at the antenna aperture. It is the end-to-end NE $\Delta$ T of the radiometer, including all the contributing factors; some of the factors are listed in the Section 3.1.4.1. NE $\Delta$ T is defined as the standard deviation of the radiometer measurement. The radiometric sensitivity values in Table 3-1 are defined for the corresponding integration times. The vendor shall use these integration times for the calculation of NE $\Delta$ T and for determining satisfaction of NE $\Delta$ T requirements. These times are not meant to suggest actual sample integration times.

#### 4.1 Improved Surface Spatial Resolution

Improved surface spatial resolution (i.e., smaller surface measurement footprint) is desired at 10.65 GHz, 18.7 GHz and 23.8 GHz. Increased surface spatial resolution for the higher frequency channels (e.g. 36.5 GHz , 89.0 GHz) is not of value to the Government; in particular, spatial coverage takes precedence over resolution for the 36.5 GHz and 89.0 GHz channels. Table 3-1 in the GMI Requirements Document identifies the maximum permissible antenna beamwidth for each measurement channel included in the instrument's baseline configuration. (These beamwidths correspond to a projected antenna aperture of approximately 1.0 meters.) In Column 4 of the Table presented below, the Maximum Beamwidths for a GMI with Enhanced Performance for the low frequency channels is presented. (These beamwidths correspond to a projected antenna aperture of approximately 1.2 meters.) The beamwidths provide the ground spatial resolution desired by the Government, and represents the greatest benefit to the Government. The value to the Government for reducing the beamwidths from the values contained in the GMI Requirements Document to the value identified in Column 4 below for Enhanced Performance does not increase linearly with the decrease in the beamwidth, but rather little or no value is assigned to reductions in beamwidth until the values presented in Column 4 are approached. Also note, an antenna aperture much larger than 1.2 meters in diameter presents spacecraft accommodation constraints, and should be avoided.

**Maximum Antenna Beamwidths as Specified in the GMI Requirements Document (Column 3) and as desired for Enhanced Performance (Column 4)**

Channel	Frequency [GHz] Polarization	GMI Performance 3 dB BW [deg.] (Maximum)	GMI Enhanced Performance 3 dB BW [deg.] (Maximum)
1	10.65 V	2.05	1.75
2	10.65 H	2.05	1.75
3	18.70 V	1.20	0.95
4	18.70 H	1.20	0.95
5	23.80 V	0.95	0.80
6	36.50 V	0.90	0.90
7	36.50 H	0.90	0.90
8	89.00 V	0.40	0.40
9	89.00 H	0.40	0.40

Notes:

GMI beamwidth calculations assume a specific amplitude taper across the aperture, values are calculated from  $\theta_{3\text{dB}} = 1.27 \lambda/D$  radians and are rounded as appropriate.

The maximum beamwidths contained in Table 3-1 of the GMI Requirements Document (and also listed in Column 3, above) are consistent with a 1.0 m diameter projected antenna aperture.

The Enhancement Beamwidths for channels 1 through 5 are consistent with a projected antenna aperture approximately 1.2 m in diameter. Beamwidths for channels 6 through 9 may be achieved by under-illumination of this aperture.

For channels 6 and 7 (36.50 GHz) no enhanced beamwidths are desired. The requirements for cross-scan sampling for Channels 1 through 7 (3.1.7.3.2.1) and the maximum beamwidth presented in the above Table bound the beamwidth trade space.

For channels 8 and 9 (89.00 GHz) no enhanced beamwidths are desired. The requirements for cross-scan sampling of Channels 8 and 9 (3.1.7.3.2.2) and the maximum beamwidth presented in the above Table bound the beamwidth trade-space.